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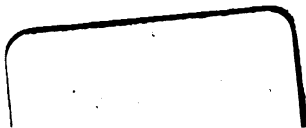




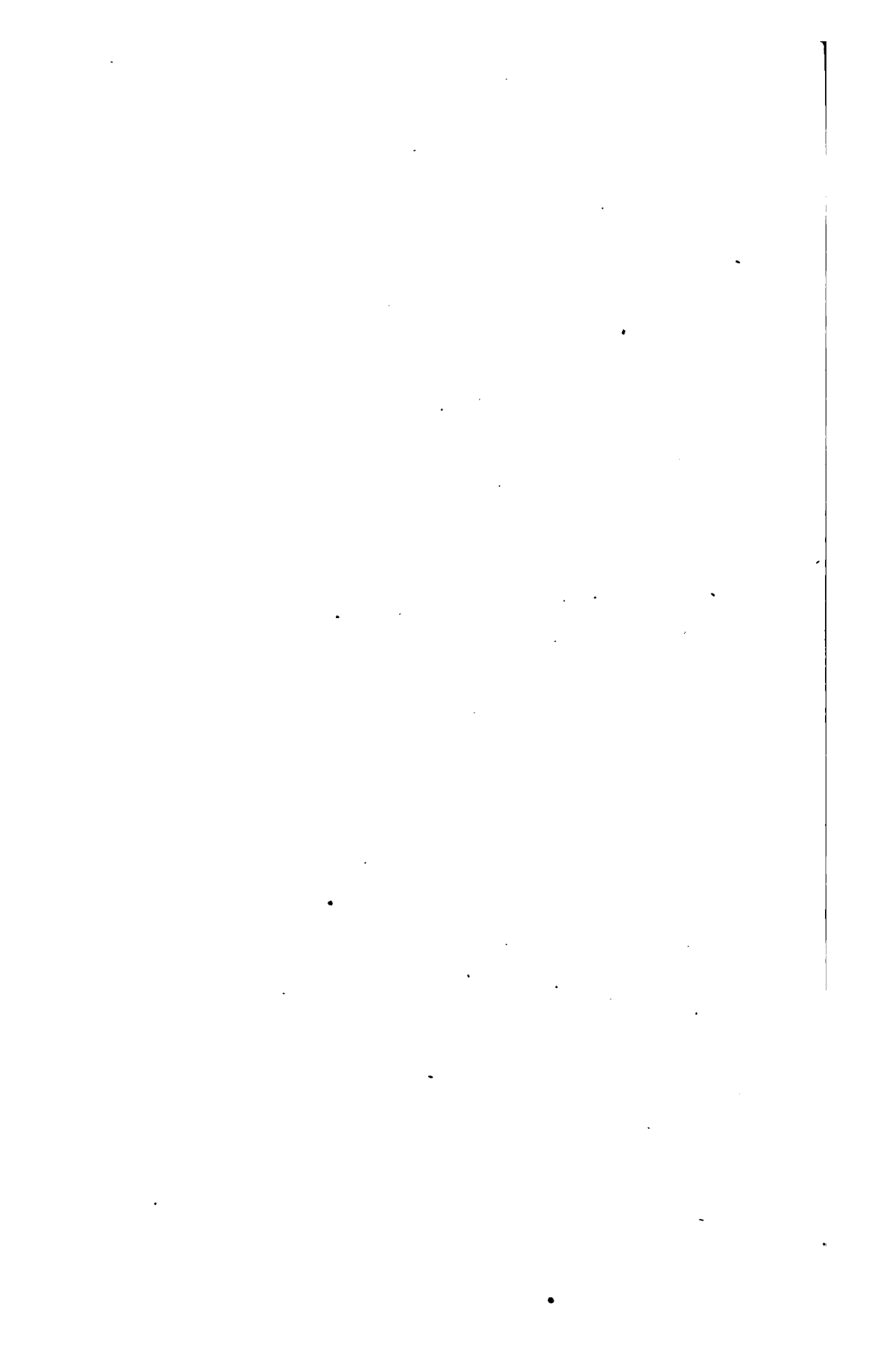
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ON
LAND-DRAINAGE,
~~AND~~
SUBSOIL-PLOUGHING,
AND
IRRIGATION.

BY
THE AUTHOR OF "BRITISH HUSBANDRY."

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1841.

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ON

LAND-DRAINAGE, SUBSOIL-PLOUGHING AND IRRIGATION.

OF all those improvements which the increase of wealth and population has occasioned to the agriculture of the country, none was, until within these few years, in so backward a state as that of drainage. Notwithstanding the improved fertility of those soils on which, in some few instances, it had been carefully tried, the owners and occupiers of the land seemed generally insensible to its value; and there was among them an unaccountable degree of apathy to its adoption, caused probably both by want of due information regarding the best modes of carrying it into effect, as well as by disinclination to incur the expense.

Our farming ancestors, although constituting an estimable race of sturdy yeomanry, were, indeed, mostly ignorant men, working upon small holdings, and with such slender capital as seldom to inspire any thought of obtaining from them more than a decent subsistence. Rents were paid chiefly in kind from the produce of the ground and personal service; the population was scanty; the product of the soil comparatively trifling; and large portions of the kingdom were either under forest, or in a state of unproductive waste. It may, therefore, be naturally supposed that little value was set upon land apparently so worthless; and it was not until long after the abolition of the feudal system that any attention was paid to its improvement. Even

then, although farmers might endeavour to carry off the waste water from the surface of their land, by cutting a few furrows across a field to communicate with the ditch by which it was bounded, yet such an operation as that of the present manner of under-drainage, for the purpose of laying the land permanently dry, was hardly known to them; for although remains have been found of some very ancient land-drains, they were only made either on the demesne of some wealthy baron, or, not improbably, on estates belonging to the monks, who were then the only enlightened husbandmen in the kingdom. The drainage of the fens in Lincolnshire and Cambridge, although a public measure of national importance proposed in the reign of James I., was not actually commenced until the time of the Protectorate, when it was undertaken by foreigners; and the present state of the Bedford Level is mainly due to the exertions of Colonel Vermuyden, a Dutchman in the service of Oliver Cromwell, who was himself a farmer, and a warm friend to agriculture.* His countenance, added to the political circumstances of the times, then induced many persons of means and education, who had been engaged in the civil war, to turn their attention to farming on the cessation of hostilities; and a still further impulse was added to it by the subsequent introduction of the turnip husbandry, which, in a great degree, altered the previous system of culture, by the progressive advancement of alternate corn and green crops, to which is chiefly owing our present eminent station as agriculturists.

The turnip husbandry, however, demands a comparatively dry soil; for one of the greatest advantages attendant upon the growth of the root arises from the power of having it

* There is existing, however, the record of an ineffectual attempt made by a company of Flemings so long ago as in the reign of Henry VII., referring, as it is supposed, to the same object.

eaten off by sheep upon the ground, and thus effectually manuring it without expense. The propriety of adopting this practice became apparent from the evident increase which it occasioned in the crops of grain, as well as by the consequent increase of rent justly demanded by landlords for soils of a description adapted, either by nature or by art, to its operation; and this, together with the certainty that land chilled by stagnant water can never make a profitable return for the labour of tillage, induced a greater attention to drainage. Still, the difficulty at that time of conducting it scientifically, and the failure in several instances of the principles put forward on the subject by Elkington, added to the sums of money thrown away in unskilful management, caused a temporary check to its general use. Farmers, however, having learned from experience that manures, whether caustic or putrescent, do not impart their intended benefit to wet soils, while those laid upon gravels, loams, or land of a light porous nature, (if not resting upon an impervious subsoil,) act to the full extent of their powers upon vegetation, are at length convinced that the only means to be relied on for the correction of this serious evil is—*to render the ground dry by drainage.*

It is, indeed, so essential to the due effect of all kinds of manure, that in the application of lime it is indispensably requisite not only that the ground should be in a dry condition, but also that the lime be laid on it in the driest season: bone-dust is now well known to be ineffectual on wet soils; and even stable-dung has comparatively less power on land in a humid state than on that which has been drained.*

* “ Although *time* readily decomposes vegetable matter, it yet only decomposes it advantageously in dry soil, or soil rendered dry by draining, the moisture in wet land rendering it effete before it has time to act chemically on

Soils of various kinds are in many cases infested with surface springs, which may frequently be got rid of with comparative ease by *open drains*, which lay the land tolerably dry wherever there is sufficient declivity to carry off the water; although, if these be cut on pasture-land, they are subject to this objection, that, if sheep be fed upon it, they sometimes render the fat stock liable to the accident of being cast. If, however, those springs be lower down, and found at different distances in alternate strata of sand and clay, or gravel, their depth should be ascertained by boring; as the land can never be laid dry until perforated to the bed of impervious subsoil upon which those strata rest, and upon which *covered drains* must be sunk for the complete escape of the superabundant moisture. It should also be borne in mind, that, although open and covered drains may have partly similar effects, they are yet essentially different in execution, and should never be used together in the same operation; for if the surface water be allowed to get into the covered drains, the sand and earth which it will carry into their channels will be apt to choke them up.

Heavy clays also, like those, for instance, in the wealds of Kent and Sussex, or any land retentive of water, and lying upon a dead level, can never be rendered efficiently

the vegetable matter in the soil. Before the application of lime in any circumstances land should therefore be thoroughly drained."—P. 175.

"Whatever may be the chemical action of *bone-dust* on soils, we can assert with confidence that bone-dust will impart no richness to any kind of soil unless the land is either naturally dry or has been drained, and the more thoroughly it is drained the greater effect will bone-dust have upon it as a manure."—P. 176.

"The perceptible dampness in undrained soils dissolves the soluble portion of *farm-yard manure*, which, by its gravity, descends beyond the rootlets of young plants, whilst the strawy portion remains undecomposed for a length of time, which may account for the invariable languid vegetation of plants, while young, in undrained land."—P. 173.—*Quart. Journal of Agric.*, N.S., No. 38.

productive without the most thorough *under-ground drainage*; for, the water being upheld upon the surface during the winter, the ground must be ridged up at a great expense of toil and wages for the purpose of exposing it to the sun and air; yet still vegetation flags until an advanced period of summer sunshine evaporates the injurious humidity occasioned by the falls of snow and rain. In this state, indeed, may be found some of the richest land in the kingdom, consisting of alluvial layers of absorbent earth over a substratum of adhesive clay, with a surface of little or no declination, which, thus retaining the superfluous moisture, retards the progress of vegetation; added to which, if the land be in grass, it will be materially injured by the poaching of cattle pastured upon it in wet weather; and, if sheep be put upon it in autumn, it will go far to rot them.

Hence the plants become sickly, the harvests are generally late as well as precarious, and the crops not unfrequently deficient in both quantity and sample. Yet numerous instances might be adduced of not only such lands, but of soils of every description, which were reduced almost to the state of worthless swamps by the retention of stagnant water, having been converted into sound turnip land, worth more than double the rent at which they were originally held; and that simply by the simultaneous operation of subsoil-ploughing and under-draining, at an expense which, in many cases, has been repaid by the increased value of a couple of crops. Indeed, it appears, by a communication recently received from Mr Robson, the land-agent of Earl Grey, in Northumberland, that the entire charge of drainage has been covered by a single crop of Swedes; and many communications from other quarters have been made to the same effect.

Notwithstanding a manifest disinclination on the part of most farmers to afford information on the profits of

drainage,* yet, in order to remove any doubt which might be entertained of the success of the operation, the following accounts, taken from a variety of cases, may be not inappropriately quoted.

One of these, lately published, contains the particulars of a purchase made by Mr. Denison, of Kilnwick Percy, of about 400 acres of rabbit-warren, of an apparently sterile sand, with a heavy ferruginous subsoil, the hills covered with heather, and the hollows a bed of marshy aquatic plants. The cultivation had been abandoned; as it was found, though pared and burnt, not to produce more than three quarters an acre of oats, and the land was let at 2*s.* 6*d.* the acre. Mr. Denison then subsoil-ploughed a portion of it, and tile-drained it with soles at every twelve yards apart, at the cost of 5*l.* 4*s.* 8*d.* the acre, exclusive of the carriage of the tiles from the manufactory. The land, being afterwards manured in the common way, has produced ten and a half quarters per acre of Tartarian oats, which fetched 26*s.* per quarter; and now bears wheat and oats on a property which was previously considered useless.†

In the same publication it is also stated, that some land belonging to the Rev. Mr. Croft, of Hutton Bushel, which was not thought worth 5*s.* an acre, is now let at a guinea: “evidently from the effect of the drainage by the breaking up of the Moor-Pan.”‡

Sir James Graham likewise mentions his having recently

* Of this, however, there are exceptions; as, for instance, Mr. Dudgeon, a tenant on the Falkland estate, in Scotland, has given a very detailed and interesting account of the drainage, which he concludes by stating “that the effect of the operation has been to convert a very considerable extent of land, a great part of which was formerly a mere swamp, into a rich and fertile soil, now producing luxuriant crops of oats, turnips, and grass.” See *Prize Essays of the Highland Soc., N.S.*, vol. ii. p. 74.

† See *Transactions of the Yorkshire Agric. Soc.*; and *Journal of the Royal Eng. Agric. Soc.*, vol. ii. art. 2.

‡ *Journal of the Royal Eng. Agric. Soc.*, vol. ii. p. 35.

let a farm at 20*s.* an acre, after its having been subsoil-ploughed and drained, which had been valued before the operation took place at 4*s.* 6*d.* per acre.* The cost of this improvement was 6*l.* 18*s.* 4*d.*, as follows:—

70 roods of draining, cutting,			
laying the tiles, and upfilling,	£.	<i>s.</i>	<i>d.</i>
at 4 <i>d.</i> per rood	1	3	4
1500 tiles per acre, at 30 <i>s.</i> per			
thousand	2	5	0
Carriage of do., 6 <i>s.</i> per do. . .	0	9	0
Do. of turf for covering the tiles,			
and cutting do., 70 roods, at			
6 <i>d.</i> per rood	1	15	0
Ploughing with the Deanston			
plough, and four horses . . .	1	6	0

Thus yielding an annual interest of rather more than eleven per cent. on the outlay.

I have moreover the authority of the Marquess of Tweeddale for stating, that the increased product of his home farm, at Yester, in Scotland, has been nearly two-thirds on most of the crops, and in some cases much more, upon all the land which has been subsoil-ploughed and drained. One field, indeed, which his Lordship declares to have formerly carried only 17 bushels of oats per acre, has given 67 bushels of barley, after having been trench-ploughed and drained.

These improvements by means of drainage, although clearly evincing its importance, both to the landlord in the increased value of his property, and to the farmer in the production of his crops, are yet less decisive than that which I shall here briefly attempt to describe.

The extra-parochial place of Teddesley Hay, in Stafford-

* Journal of the Royal Eng. Agric. Soc., vol. i. p. 32.

shire, is the residence of Lord Hatherton, and contains 2586 acres. It was originally part of the forest of Cannock, and, with the exception of two anciently enclosed parks—one of them containing 589, the other 198 acres—continued unenclosed till the year 1820, when the whole became, either by allotment or purchase, the property of his Lordship.

Since then Lord Hatherton has been engaged in laying out this tract and the adjoining land in a manner suitable to the neighbourhood of his residence, by making large plantations and an extensive farm; the old park fences having been thrown down, and the whole of the lands subjected to a new arrangement.

The extent of the farm-lands is 1832 acres, comprising a range of high and dry hills to the east, adjoining Cank Chace, which hills were formerly an extensive rabbit-warren, covered with heath, or fern. From the hills the lands slope gradually, with slight undulations to the west, down to the River Penk—a distance of somewhat about three miles.

Having heard this tract of land below the hills mentioned as exhibiting in a striking manner the results both of judicious draining and employment of the water so obtained, I took an opportunity of visiting the place in the latter end of May, 1841. I was conducted over it by Mr. Bright (the respected land-steward in the management of the property), who gave me the details contained in this paper; and, on riding through the farm,—which then presented an appearance of the most luxuriant vegetation,—described to me the condition of the lands in 1820. The larger park, which had been long divided into fields, was ill cultivated, and the lesser park might be fairly viewed as one bed of rushes. The circumjacent common-

lands were also covered with heath or rushes, and, in the lower parts, with alder. The extent of surface which did not require draining was comparatively small; and the whole consisted generally of a light soil, rather inclined to peat; the subsoil being chiefly a stiff clay.

While the enclosure was in progress, some very deep drains were made in the marshy lands of the larger park, which were effectually drained, and from which large volumes of water now issue. As soon as the enclosure was completed, other deep drains were made on several parts of the allotted waste, and for the most part with excellent effect.

Things were in this state when Mr. Bright became agent to Lord Hatherton, about eleven years ago. He immediately conceived the notion of putting the waste allotments, containing a surface of nearly 600 acres, through a regular course of thorough drainage, and afterwards collecting the whole of the drain-water into two main channels; with the double intention of conducting one of them through the farm-yard, for the purpose of obtaining by it a water-power for various objects connected with the estate, and then employing it, in conjunction with the other stream, in making an extensive tract of upland water-meadows.

The plan occurred to him in consequence of there being no natural stream on any part of this land. It must however be acknowledged to have been a bold attempt, which could only have been conceived by a comprehensive mind and a man of great practical knowledge; but it was liberally seconded by his noble employer, and has been accomplished with admirable success: as the following statements will sufficiently explain.

First, as to Draining :—

The following is a statement of the improvement by drainage, and the expenditure, during the ten years preceding 1841, upon such parts of the estate as have been drained:—

Quantities.	Value of the Lands in their original state.			Amount of Expenditure in Under-draining.	Value of the Lands in their present state.		
	Per Acre.	Annual Value.			Per Acre.	Annual Value.	
<i>a. r. p.</i>	<i>s.</i>	<i>£. s. d.</i>	<i>£. s. d.</i>	<i>s.</i>	<i>£. s. d.</i>	<i>s.</i>	<i>£. s. d.</i>
78 1 36	10	39 4 9	262 15 0	27	105 18 9		
19 1 32	10	9 14 6	74 9 8	35	34 0 9		
38 0 3	16	30 8 3	52 14 2	40	76 0 9		
82 2 2	15	61 17 8	346 16 4	30	123 15 4		
30 3 24	10	15 9 0	121 5 8	35	54 1 6		
81 1 34	8	32 11 8	153 16 4	22	89 12 2		
36 3 16	10	18 8 6	142 8 0	30	55 5 6		
33 0 0	8	13 4 0	80 5 2	26	42 18 0		
10 2 33		..	90 8 0	50	26 15 3		
10 0 8		..		21	10 11 0		
9 0 0	12	5 8 0	76 9 8	30	13 10 0		
15 0 11	16	12 1 0	41 9 4	33	24 17 3		
21 2 10	15	16 3 5	66 0 0	30	32 6 10		
467 0 9	..	254 10 9	1508 17 4	..	689 13 1		

The main drains have been laid about 3 feet deep, with tiles about 5 inches wide by 12 inches long. The branch drains are about 2 feet 6 inches deep, and are laid with tiles about 4 inches wide by 12 inches long. The cost of the former was about 45*s.* and the latter about 35*s.* per thousand, when purchased at the kiln. The cost of cutting and laying the main drains was about 1*s.* per rood of 8 yards, and the small drains about 9*d.* per rood; but it should be observed that in this part of Staffordshire the labourers' wages are from 2*s.* to 3*s.* per week higher than

they are in many other counties, on account of its being near the important iron and coal mines, as well as the Staffordshire potteries. In some of the valleys the substratum is of a loose mixture of sand and gravel, and in those places it was found necessary to adopt drains varying from 5 to 8 feet deep, which pour forth large bodies of water both in summer and winter.

These lands having been effectually drained, Mr. Bright's next object was to collect so much of the drain-water as the levels permitted into two main carriers, for the purpose of employing them as a power to turn a mill-wheel, and afterwards to be applied in irrigation. For the former object, a small reservoir has been constructed, at a favourable level, about half a mile distant from the farm, the buildings of which are in a central situation. Here at the farm-yard a mill has been built; and it is a work which, both in its conception and execution, does infinite credit to Mr. Bright, for not only is there much merit in various contrivances by which the water is conducted to it, almost everywhere in covered drains and carriers, but it was necessary to seek a level to carry off the water at a considerable depth, by driving a head-way through a bed of hard sandstone from a distance of about 500 yards. The stream of water was of course not sufficiently powerful to turn an under-shot wheel; and, to enable it to act with force, it was necessary to bring it out to the upper part of a wheel of 30 feet diameter. This wheel has been placed in the rock 35 feet deep, and the head-way has been carried from the bottom through the rock, which comes out in a valley below, at the distance, above mentioned, of 500 yards.

The mill and this channel for the water cost very little more than 1000*l.*; it works a thrashing-machine; cuts hay and straw, and kibbles oats and barley for a stock consisting of about 250 horses and cattle; grinds malt; and

also turns a circular saw, which does great part of the sawing for a large estate. The annual saving by this machinery has been carefully estimated at about 400*l.*, and it is still intended to apply the power to other purposes.

From this wheel, and from another small carrier, which is made to pass immediately under the farm-yard (where all the urine and moisture that runs from the manure is carefully collected in a reservoir, which overflows into the carrier), the water has been conducted over lands,—principally uplands,—containing altogether 89 acres, at an expenditure of only 224*l.* 4*s.* 10*d.* : by which an improvement of 2*l.* per acre has been effected, or 178*l.* per annum. This is Mr. Bright's calculation ; but it is difficult to estimate the importance of such an acquisition as 89 acres of productive water-meadow to a large farm like this, on which there is (especially on the upper part of it) a great quantity of very dry and thin soil. I know no other place in which drain-water has been turned to such good account; luckily, the water is all soft, and good for irrigation.

SUMMARY.

TOTAL EXPENDITURE.

	£	s.	d.
Underdraining, as per statement . . .	1508	17	4
For erecting water-wheel and machinery .	1000	0	0
Irrigation	224	4	10
	<hr/>		
	£2733	2	2

TOTAL INCREASE IN VALUE COLLECTED.

	£	s.	d.
Lands underdrained, present value	689	13	1
„ Original value	254	10	9
	<hr/>		
	435	2	4
Estimated saving by the mill	400	0	0
Increase in value of water-meadows . . .	178	0	0
	<hr/>		
Being an increased annual value of . . .	£1013	2	4

resulting only from draining 467 acres, and employment of the drain-water over 89 acres of land: *affording a clear annual interest on the outlay of full 37 per cent.!*

The *subsoil-draining*, or *mole-plough*, is a valuable implement in the operation of drainage; and although the inventors of the various denominations now in use each claim different degrees of merit, yet they all tend to the same object—that of loosening the tenacious substratum, and thus allowing both the water to filter through it, and the roots of plants to spread themselves in search of nourishment. There is, however, much difference of opinion amongst those who have employed it: “Some eminent farmers maintaining that it is lost labour, while others, equally eminent, think that no system of management is complete without it.”* There have been, indeed, some extraordinary instances mentioned in the “Transactions of the Yorkshire Agricultural Society” of conflicting testimony on the subject, made by men of equal credibility, whose experiments have shown totally opposite results; but it would seem that this must have arisen from the fact that, although the land upon which their trials were made appeared to be equally stiff, yet the soils were not of the same quality: the one being so much more clayey than the other, that it would run together in a wet season without exhibiting any symptom of having been under-ploughed. The soil should, therefore, be analysed, to ascertain the quantity of *alumen* which it contains; for if so large a portion as forty per cent. of that cohesive substance be found united with the other earths of which it is composed, the operation of subsoiling, without draining, will not, it may be feared, be permanently successful.

If, however, the intention be merely to break through

* Brit. Farm. Mag. for April, 1841, p. 109, and Journal of the Royal Eng. Agric. Soc., vol. ii. art. 2.

that indurated mass of matter termed "moor-band," or "pan," which is so frequently found imbedded between the upper and the lower layers of the soil, the plough alone may have a decidedly good effect; but if the lower layer should contain so much tenacious clay as to be retentive of water, no benefit can be derived from it, unless it be connected with drainage. Of this, indeed, a remarkable instance has lately been related of an experiment made by that very highly-informed agriculturist the Rev. Mr. Rham; of which the following is an extract:—

"The field which was the subject of the experiment was once a portion of the open common in Windsor Forest, and brought into cultivation in 1813. The soil consisted of a very moderate loam, inclined to yellow clay, only a few inches in depth; the subsoil chiefly a stiff clay, but with occasional portions of a very gravelly loam, nearly impervious to water. The land, being slightly undulated, and sufficiently inclined to let off the surface water by means of open drains, was usually dry enough to let the turnips be fed off upon it by sheep; and being pared and burnt, chalked and manured, it bore a fair *avé*rage of crops. Six acres of this land were subsoil-ploughed in 1838, to the depth of 14 or 15 inches, by the Rackheath plough, which stirred the subsoil 9 to 10 inches deep, after a common swing-plough had made a furrow of about 6 inches. The land was sown with turnips, but, the winter being wet, it was soon necessary to remove the sheep; and the ground—which had been so loosened by the subsoil-ploughing as to hold water like a sponge—was found too hollow either to bear the cart-wheels or the tread of horses for carrying off the roots. The operation was, therefore, ruinous to the land, and the only effectual remedy was to underdrain it. This being immediately done with footed tiles, a copious mass of water ran out, and, soon

after the drains were covered over, the sheep were returned to the fold; the cart took the daily supply of turnips to the cows; the following crop of oats was nine quarters per acre; the field has been during the succeeding winters as dry and sound as any pasture on the farm; and, according to a recent personal communication, 'there is now standing on it a splendid crop of wheat.'

"The conclusion to be drawn from this experiment is," as Mr. R. says, "important; as it shows that, wherever the subsoil is retentive of moisture, complete underdraining is essential, and the subsoil-plough should never be used until the water can run off below. It also shows what an improvement can be made on moderate land by the union of draining and subsoil-ploughing. The cost (which was 5*l.* per acre) is nothing when compared with the result; and," he adds, "I consider the sum laid out on this field as the most profitable investment I ever made." He concludes by saying, "that the subsoil-plough does wonders in lands which have a porous subsoil, even when employed by itself; but, *unless its application on stiff wet lands be accompanied with draining, it makes them worse: keeping in the water which would otherwise run off the surface.*"*

All farmers are not aware that land, *if meant to be irrigated*, should be, in most cases, even more deeply drained than common meadow. Although draining and irrigation are apparently of opposite means, they are yet equally beneficial in their effect on the herbage; for *flowing water*, if at complete command, so that it may be laid on and taken off at pleasure, and discreetly used by a skilful husbandman, invigorates and sweetens it, while *stagnant*

* See "Experiments on the Improvement of Poor Lands," by the Rev. W. L. Rham, vicar of Winkfield.—Journal of the Royal Eng. Agric. Soc., vol. i. art. 30.

water fills the sward with grasses of the coarsest character. It is indeed thought by many intelligent graziers to engender an insect which spreads itself over marshy ground, and, being there eaten by sheep along with the grass, is supposed to occasion the rot. Whether this be the fact, or not, it might be difficult to determine; but it is well known that, if land which is irrigated be not also thoroughly drained, it will, when pastured, occasion that fatal malady. Although no irrigated meadows can be said to be quite safe for sheep in the autumn, they are yet generally considered to be free from danger in the spring: but when the drainage has not been duly performed, they have been known to cause the rot in all seasons; and it has in many cases been found necessary to deepen the drains, for the purpose of completely removing the water.

Some startling facts on this subject are stated in a very interesting publication regarding the extraordinary success of irrigation on the estate of the Duke of Portland, in Nottinghamshire. One of which mentions that ewes and lambs fed upon a piece of land which had been drained in 1826, and regularly irrigated, invariably gave them the rot in spring; until, in 1837, it was more effectually drained, and the out-fall rendered complete: since which all appearance of the disease has ceased.

It is there laid down as an axiom demonstrated by a long course of experiments, "that a complete and perfect drainage of the bottom-water is absolutely necessary; its noxious effects showing themselves at a depth and under circumstances which could hardly be credited by any but those who have actually witnessed them." It then says, "it is not uncommonly held by persons conversant with draining, that, if the land is filled with shallow drains, so that no *top-water* can lodge, and that all *bottom-water* which should rise to the level of those drains should be

carried off, then all that is necessary has been done. But if, instead of shallow drains at 20 inches, the case should be put of land well filled with drains at five feet deep, it would be doubted by few that such land would certainly be secured from all the bad effects of bottom-water." The account, however, mentions instances to the contrary, which it is unnecessary to copy; but it concludes by stating, "that to effect a perfect drainage, spring-water pressing upon the land should in all cases be cut off; and, in land to be watered, a more thorough drainage is requisite than for any other purpose:"* the truth of which no one who really understands the business professionally will seriously question; for irrigation adds so much to the springs that, in many cases, the drainage has to be done twice over.

It cannot be doubted that, if all superfluous moisture be removed from the ground, it will promote healthy vegetation, and in a great degree prevent the recurrence of that frequent injury to which the flocks of farmers are exposed by the rot. The herbage will also be found so much richer, that the same quantity of hay will yield a greater amount of nourishment to live stock; and, if sheep be fed upon the pasture, it will strengthen the staple of the wool. Nor is this all: it also checks those baneful exhalations which cause the climate to be so dangerous in the fenny districts, and thus renders it, in every point of wealth, health, and comfort, a truly national object; which, although it may be viewed as a secondary consideration by

* John Evelyn Denison, Esq., on the "Duke of Portland's Water-Meadows at Clipstone Park."—*Journal of the Roy. Eng. Agric. Soc.*, vol. i. art. 39.

See also the "*Quart. Journal of Agric.*," vol. v. p. 503, in which an instance is mentioned of a large tract of land, which was constantly fed during fifteen years by ewes and lambs, without any symptom of rot; but after being irrigated and partially drained, although a great improvement was made in the quantity and quality of the herbage, yet, so far as the rot is concerned, it has been equally fatal to every sheep fed upon it.

those who look solely to self-interest, yet cannot be treated with total disregard.*

These observations may perhaps be thought needless; for the advantages arising to the soil from its melioration, by *thorough under-ground drainage*, are now so justly appreciated by its occupiers, that they universally consider it as the standard basis of all essential improvement in the land, and the main-spring of what may be distinctively termed "GOOD HUSBANDRY." But so much depends upon the nature of the soil and subsoil, and the inclination of the strata, as well as the various localities of the lands intended to be drained, that it is difficult to lay down rules for the process. It is, therefore, not to be wondered at that they do not agree as to the best modes of effecting it: some using stone, or rubble, brush-wood, peat, turf, or any substance which may be at hand and obtained at trifling cost, and filling those "rumbling drains," as they are called, with rubbish; without calling in the aid of a practised land-surveyor to lay them down at the proper distances, depths, and levels, to render them efficient;—imagining that in saving a little expense they are gainers; though, in fact, they frequently thus expend their time and money to little good purpose, and verify the homely adage of being "penny-wise and pound-foolish."

Every farmer who is familiar with the use of the spirit-level conceives himself competent to the drainage of his

* "The hurtful effect of rime, or hoar-frost, on vegetation, is a circumstance familiar to all who have had experience of cold elevated districts, or of lower lands subject to exhalations, and is found, even in the warmest seasons, to be productive of serious inconvenience to the growing crops, and that chiefly at the period when the grain is approaching to its maturer state. This evil, it may be said, has been removed by drainage, and is now so little felt, that the grain produced in the very hollows has for many years escaped the smallest perceptible injury from this cause." See Black's "Account of the Drainage of an Estate in Berwickshire."—Prize Essays of the Highland Soc., N.S., vol. i. p. 234.

land without the assistance of a surveyor; and, in cases applying solely to clays and surface-drains, the object is generally well effected. But, in springy soils, the springs must be sought for wherever they can be discovered, and the water carried from them in efficient conduits at whatever depth they may be found; for if the water be forced to find its way through the earth without artificial assistance, the greater portion will remain there in a stagnant state: thus turning good land into bad, and causing the injury to which allusion has already been made. This, however, demands more scientific knowledge than most farmers possess; and if they have land of that nature to drain, they would do much better to employ a professional man to commence and superintend the work, than to rely upon their own judgment, and thus, perhaps, injure their land by unskilful management. In being thus guided by a person who is in the constant habit of laying out drains, and who has the opportunity of observing their operation and effect in every variety of situation and soil, they will assuredly find that many errors inseparable from first trials will be avoided, and much expense saved in the prosecution of the practical details; while his charges will be but trifling in comparison with the advantages which will probably be derived from his directions.*

Of this any one who is aware of the great difference in the nature of soils must be sensible, if he reflects for a moment upon the steps which should be taken previous to the drainage of an estate. First, the surveyor has to make himself accurately acquainted with both the nature of the adjoining land, and its inclination, if it be higher than that to be drained. He should then measure the extent, and carefully examine the different strata, of every field of

* See Black's "Account of the Drainage of the Estate of Spottiswode," Prize Essays of the Highland Soc., N.S., vol. i., and "Thoughts on Fertilizing the Soil."—Quart. Journal of Agric., N.S., vol. vi.

which the latter may be composed; taking, at the same time, the levels of each, and using the auger freely for the search of under-ground springs. He will thus be enabled to ascertain the proper distance and the requisite depth of the main-drains, together with the number of cross-drains as feeders; each of which should be distinctly marked out upon a plan of the ground. The price of labour and materials being known, a correct calculation may then be made of the probable efficiency and cost of the operation; from which the farmer may make up his mind as to the expediency of undertaking it, without being heedlessly drawn into those losses which have been so often occasioned by inexperienced drainers. If determined upon, the object is not unfrequently carried into effect by labourers who undertake the work "by the job." It is however so much their interest to slur it over with as little trouble as possible, that they must be more than commonly honest if they do not endeavour to cheat their employer by doing it imperfectly. It is, therefore, perhaps better to employ day-labourers; but, in either case, the operation should be committed to the inspection of some steady fellow, who must take care not to allow a foot of drain to be filled up without closely examining the manner in which it has been done.*

A great degree of local observation regarding the nature of the ground, combined with practical knowledge and skill in the execution of the work, is requisite in cutting

* "The doing the work insufficiently is often nearly as bad as the leaving it undone. The defects of half-draining frequently cannot be discovered until a great loss has been sustained, and to remedy such defects it is for the most part necessary to make new drains entirely, which generally cost as much, and in many cases more, than the first outlay." "As an instance in point—the expense of lifting drains which had been imperfectly formed in a field on the estate of Lord Strathallan, in Perthshire, and which had thus stopped or become *blown*, and the water forced to the surface, was 16*l.* 10*s.*, and the cost of new drains was only 13*l.* 14*s.*."—Stephens on "Furrow-Draining," Quart. Journal of Agric., N.S., vol. iii. pp. 291, 292.

off the water of the springs at their source. If not done effectually at first, the drains must afterwards be deepened at considerable additional cost; whereas one deep drain, if judiciously placed, will generally preclude the necessity of any other, and, should any doubt be entertained respecting the proper depth, the safest way is to make it rather too deep than too shallow. This, however, applies solely to those *main-springs* which lie far below the surface of the ground, for the injurious effects of *land-springs* are, as already observed, very commonly remedied by open drains. As these are apt to be dried up in summer, the farmer is, notwithstanding, often reconciled to bear with their pernicious consequences, and we thus see vast tracts of meadow left by this practice in a state of marsh: though it is a very ill-judged economy, as the expense of drainage would soon be repaid by improvement in the sward.* Whether these springs be perpetual, or only temporary, they should, therefore, be diverted from the surface either by open or under-ground drainage; and the latter, as being the most effectual, will, in the long run, be unquestionably found the cheapest.

So various are the soils and situations of farms, and so many are the gradations between the extremes of light absorbent sands or gravels and cohesive clays, that no uniform system of drainage can be applicable to them all. Our object is indeed rather to excite attention to the subject than to offer instructions on the proper mode for each; which would not only swell this brief notice into a tedious essay, but would doubtless be also thought, by

* "There is a field on the estate of the Earl of Leicester, at Longford, in this county, which some years ago was occupied by Mr. John Sherratt, and brought forth rushes in such abundance that he gave leave to anybody who would be at the trouble of mowing to carry them away. Three years ago the field was drained; and this year we are told the present occupier, Mr. T. Robinson, has cut three tons an acre of as nice herbage as ever grew." —Derbyshire Chronicle, 25th July, 1841.

those who are professionally conversant with the subject, to savour somewhat of presumption.

It may, however, be observed, that those light loams, or sands and gravels intermixed with a portion of pure clay, resting upon beds of gravel, and which compose the true "turnip soils," rarely require draining: but in those which consist of sandy and gravelly strata, resting upon various kinds of clay (and comprising, perhaps, the greatest portion of the arable land throughout the kingdom), the water filters through them until it meets with the impenetrable layer by which its further progress is stopped. On this layer the drains should be placed, and sunk into it just so far as to allow a free passage for the water; unless it should be very near the top soil, in which case the drains must be sunk still further down: but, if the soil be wholly clay, it will be useless to sink them lower than sufficient to guard the materials with which they are covered from being injured by the tread of heavy cattle; or, in arable land, from being disturbed by the action of the plough.

It is obvious that the depth of drains, and their distance from each other, must be governed by the nature of the soil. It is also evident that "the flatter the surface, and the stiffer the soil, the greater will be the number required;"* and the intermixture of several different layers renders the drainage more complex and difficult to manage than if the land consists simply of an upper and an under stratum. Generally speaking, however, it is thought that the object will, in most cases, be completely attained, if the main drains be carried to the depth of 30 inches to 3 feet, or at the most to 3½ feet—the depth of the smaller drains, or tributary feeders, being about 6 inches less. The main drains should be cut deeper than the side ones, in order to prevent the water in them from standing back when the main

* Penny Cyclopædia.

is full. It will also, in most instances, be found more prudent to carry the main-drains diagonally, across the slope of any rising ground, than to dig them straight down the declivity; whereby a rapid fall is occasioned, which is apt, in heavy rains, to sludge them up with earthy impurities, besides draining the water chiefly from one point: whereas, if placed in a slanting position, they will intercept it in its descent from every part of the land, and thus gradually collect a much larger quantity, without carrying along with it anything to choke their channel. Nor should the cross-drains be cut at right angles to the main receivers; but made to join them in an oblique direction, tending downwards, so as to secure the course of the water in its passage to the outlet. Their distance must, of course, be regulated by the state of the land; for, if it be of a decidedly retentive character, the drains will not act effectually if more than 20 feet apart, and it has sometimes been found necessary to place them at only 12 feet apart. If, however, it be of a porous species, they will act at from 40 to 50 feet asunder; but from 18 to 30 feet may be considered a usual average.*

Notwithstanding what has been here said, it must be understood that, if the ground be nearly level, every advantage should be taken of any declivity which it may offer; and, if entirely flat, the drains should be constructed with a gradual fall to the outlet into which the water is to be discharged, which, whether ditch or rivulet, should always

* It has been held as a rule, to apportion the area of all drains to their length, declivity, and distance from each other. Thus, supposing the length to be 200 yards, and the distance from drain to drain 18 feet, the square feet of surface receiving rain-water in 24 hours will give 1800 cubic feet of rain-water; and taking the sectional area of the smallest, or $2\frac{1}{2}$ to 3 inch tiles, at 7.5, and the water moving in this aperture at the rate of one mile per hour, the number of cubic feet discharged by the drain in 24 hours will be 6600, or nearly four times as much as is necessary to carry off a surface fall of two inches of rain. See Prize Essays of the Highland. Soc., N.S., vol. vi. p. 94.

have a deeper bottom than the drain itself. To secure this regular descent, so that the water may run from one end to the other of the drain, without its being in any way impeded or suffered to stand dead, is a matter of serious importance. Although every one knows that water will flow at a very slight inclination from its level, and it may be true that "there is more danger attending the greater than the lesser fall," yet the exact rate at which the proportion of that inclination should be measured in making drains on level ground—or the fall which they should have in order to the attainment of their object—has given rise to considerable variance of opinion among professional men. Thus, in the "Penny Cyclopædia," one foot is stated as sufficient fall for a drain of 300 feet in length, provided the drains be not more than 20 feet apart. One writer assumes that "a fall of one inch in 20 feet is sufficient;*" while another insists that "no drain should have a fall of less than one foot in 75;"† others again, one foot in 100, up to 150; and one gentleman, in treating of tile-draining, says, that "Tile-drains will act with very little fall; one foot of fall in every 1000 feet in length will be perfectly safe; though it is best to have one foot of fall to every 300 feet of drain."‡

Although admitting the superiority of tiled drains in allowing a free passage to the water, yet the soundness of his view of the subject may be doubted; and, on discussing it with an eminent land-surveyor (Mr. Deane, of Tottenham) who has been extensively engaged in drainage, he stated, "that in the course of his practice he always found those hollow drains to continue longest serviceable

* Carmichael, of Raploch Farm, on Tile-Draining.—Prize Essay of the Highland Soc., N.S., vol. vi. p. 85.

† Thoughts on Draining.—Quart. Journ. of Agric., N.S., vol. iii. p. 88.

‡ Wilson on Tile-Draining.—Prize Essays of the Highland Soc., N.S., vol. vi. p. 114.

which had a good fall ; and that he would recommend not to be too sparing in giving them such a fall, whenever the circumstances of the case would admit." Perhaps, therefore, a declivity of one foot in 120 may be sufficient to secure a proper current in the main : paying attention at the same time to the fact, that, if the water does not run at increased speed towards the bottom of the drain, it will probably occasion deposits of sediment.

It should also be observed that, if the field be of large size, receiving drains, or ditches, must be opened at different distances—say not farther apart than 200 to 300 feet ; for otherwise the necessary artificial fall of the drain at the rate of one foot in 120, would bring its excavation to an inconvenient depth, even if the outlet be deep enough to receive it ; besides occasioning such a collection of water as during continued rains might endanger its safety by causing it to burst.

A great portion of the heavy arable ground throughout the kingdom is rounded-up into permanent "lands," of various breadth and height, according either to its wetness or to the custom of the country ; with the intention of causing the rain-water to run from the surface into the furrows, which act as so many open drains in carrying it off. It is thus not unusual to see good crops of corn growing on the crown of these ridges, while their sides, being bared of the best soil by its collection on the top, are rendered comparatively worthless, and the crop inferior in both bulk and quality ; whereas, if the lands were well under-drained, the height of the ridges could be reduced, and, the soil which is taken from their sides being then replaced, the crops would be found equal in every part. This, it is true, is sometimes done, and always with good effect ; but those covered drains are most commonly sunk in the furrows, with a view of saving labour, although they could

often be more judiciously placed in a different direction, and in no case should their distance be influenced by the size of the lands, as these are in many instances no less than 30 feet wide, and drains may be necessary at half that width. This, however, must not be construed into a recommendation of altering the form of the lands, which is always a difficult and frequently an unprofitable operation; but even when their size, and the inclination or bend of their declivity, are in every respect unobjectionable, and the course of the furrows such as a surveyor would approve, it might perhaps be better to sink the drain in the very centre of the ridge. Some intelligent farmers, indeed, place them within three or four feet of the furrows, and find that plan very advantageous. Should the drains be, nevertheless, made in the furrows, then care should be taken to sink them a few inches deeper than if made in level ground; in order to prevent the injury which might otherwise be occasioned by the tread of horses at plough, when stepping in the trench. Nor should the covering materials which are placed over the water-channel be formed merely of the soil which has been dug out of the drains; for if that be loose earth, it may find its way into the channel and choke it up; or, if it be clay of an impervious nature, and trodden down by the working of the cattle, it will materially impede the good effect of the drainage.

Among the many expedients which have been resorted to for the purposes of under-drainage, none has been longer or more universally employed than stones; and, in situations where they can be found in sufficient abundance upon the land, of a smooth, rounded form, not larger than the size of a man's fist, they will no doubt continue to be used, as good and durable drains can, in that case, be made with them at moderate cost. But if they are to be quarried, or to be carried from any long distance, they

become so expensive that many persons have given them up; not only in consequence of that objection, but of others which will be hereafter stated. Schemes have also been adopted—such as the filling up of the conduits with peat, or with bands of twisted straw—and there is one, called “wedge” or “plug-draining,” which has been within these few years rather extensively used in some of the strong clays; to which alone it is applicable, and better adapted to pasture than to arable land.

The operation is commenced by cutting a turf of 12 inches wide and 6 inches deep, followed by other cuts at such an angle down the side of the intended drain, as will leave the bottom (at 2 feet deep) only $1\frac{1}{4}$ inches wide; into which the plug is inserted. This is exactly fitted to the channel of the drain, and formed of several pieces of wood, each being 6 inches long by $3\frac{1}{2}$ wide at the top, and $1\frac{1}{4}$ at bottom; connected by iron links, and drawn by a chain. Upon this the clay which has been thrown out is replaced, and rammed down upon the plug into as solid a state as possible; after which the plug is withdrawn and the operation repeated. The process is comparatively cheap, but more difficult of perfect execution than may perhaps be imagined, and cannot be recommended as either effectual or permanent; for it must evidently be very subject to break in, and, should any such accident occur, it will not only stop the drain, but that cannot be repaired without its being entirely re-made, as the plug must be drawn out to its very end, and cannot be lifted from the ground.*

* Where it has been successful it has, however, had such good effects, that land which in wet seasons invariably rotted every sheep put upon it is now stocked without any occurrence of such casualties; and mowing has commenced a fortnight or three weeks earlier than before it was drained. See *Farmers' Mag.*, N.S., vol. ii. p. 98, and vol. xv. p. 67, of the “*Papers of the Bath and West of England Society*,” in which it is stated that on a farm where green crops formerly rotted on the ground, 800 sheep are now fed on turnips throughout the winter.

In order to correct, so far as possible, the imperfections in these various modes, as well as in the rumbling drains to which allusion has already been made, the system of *Tile-drainage* was introduced some thirty years ago, and has since been found so much more effectual, that it has almost universally superseded every plan except that of stone-draining, and is now generally employed throughout those wide districts which are still in want of improvement. On the commencement of tile-draining great objections were made to it, from the suspicion that the tiles would decay; and the outlay of money for their purchase startled both the landlord and his tenant. In process of time, however, it has been found that drains thus constructed many years ago are now as perfect in their operation as when first formed. It has, indeed, been ascertained that good tiles do not perish in the drains; and it has been seen in the account of improvements on Lord Hatherton's property, as well as in the published statement of the drainage of the Netherby estate, (on which some thousands of acres of otherwise unproductive land have been rendered perfectly dry, and fit for every operation of husbandry by the process of tile-draining,) that, when there is occasion to lift any of the drains, the tiles are found in the same perfect state as when they came out of the kiln.*

It must, however, be observed, that really "good tiles" are essentially requisite; for if only one of them becomes decayed or broken, it stops the current of the water on the spot where it stood, and the injury cannot be discovered until damage, of sometimes a very serious nature, has been occasioned. The operation of draining,

* See "An Account of Draining by means of Tiles, as practised on the estate of Netherby, in Cumberland, the property of Sir James Graham, Bart., M.P.," communicated by John Yule, Esq., of Glingerbank.—Prize Essays of the Highland Soc., N.S., vol. i.

although amply returning the outlay, yet being very expensive, it is extremely important to ascertain not only the cost, but the intrinsic value of the tiles when made. Purchasers should, therefore, be cautious; for, if induced by comparative smallness of cost to use those of an inferior quality, they may have cause to find in the course of time that they have been actuated by false economy.

The more compact the tile is made, the stronger it will be, and the more pressure it will bear the better. It should not appear porous; and, if struck upon by the knuckle, it should, if well made, emit a metallic sound. Being, however, usually made by hand, and very generally by persons who neither understand the kind of clay which should be used in the formation of a tile which will last without decay, nor possessed of sufficient capital to work the clay during the time required for producing it of proper quality, thousands are daily made which are not trustworthy: being not only imperfectly moulded, but, "being either too much or too little burned, a night's frost has been known to break the whole tiles laid down in a drain."* The making of tiles demands, indeed, more time, and consequently more capital, than may be generally imagined. When the proper sort of clay has been discovered, it is usually dug up during the course of the year for the entire supply of the ensuing season; being turned carefully over about the preceding Martinmas, to receive the benefit of the atmosphere throughout the winter. In spring the process of tempering commences, and the tiles are not manufactured until the following summer, as large quantities can only be conveniently dried in fine weather.

* Thoughts on the Extension of Draining.—Quart. Journ. of Agric., vol. vi., N.S., p. 330. The effect of *over-burning* is however merely that of rendering the tile brittle; but if *under-burned* it then imbibes moisture, which, when frozen and afterwards thawed, occasions it to rot and fall to pieces.

It must be evident to comprehension that any common manufactured article of general use, which requires regularity of both consistency and form, can be better made by machinery than by hand. In the making of tiles particularly, the compression of the clay, which constitutes their strength and durability, can be much more effectually performed by the power of a well-constructed machine than by hand labour; and, being equal in point of solidity, no single one is more subject to decay than another. This guards them from the frequent occurrence complained of in common tiles, of drains being stopped by the falling in of an ill-made one. They are also less subject to breakage; and, being all formed alike, they can be accurately fixed in the drains. Patents have, therefore, been taken out for effecting this desirable purpose upon an improved principle; one of which, invented by the Marquess of Tweeddale, has been purchased by a company, and brought into very general use.

It is a powerful machine, worked by either horse or steam power, compressing the clay with such force as to render it far more solid and durable than any tiles made by hand. It also moulds them with extreme accuracy, and cuts them of a length to *burn* 15 inches; whilst if those made by hand exceed 13 inches, they are apt to crack, and become so warped in their openings, when burnt, as often to prevent them from being set firmly in the ground. Now, although price is of importance, durability is greater; and the advantage resulting from increased length will be apparent upon calculating the quantities required to drain a given distance: for instance, say an acre, with trenches 15 feet apart, being equal to 176 rods, would require—

of 15 inch tiles 2323

12½ „ 2788

12 „ 2904

It appears to us, indeed, to be the only invention, for the object which can be justly termed a *machine*: for, although ingenious contrivances have been put forward under that denomination, they may be more fairly called *serviceable tools*, as they only cause some saving of labour in the preparation of the clay, while the tile is really moulded by hand in the ordinary manner; and we feel convinced, upon the most careful investigation, that it has a decided superiority over every other mode.*

The Tweeddale machinery is of very simple construction, and may be briefly described as follows:—

A trough of the exact width of the intended tile is placed at the head of the machine. Into this the clay is put by a workman, and drawn through two revolving cylinders, which compress it so forcibly as to render it extremely firm and solid. The clay, thus flattened to the required thickness by the rollers, is then drawn forwards by the machinery, and passed through moulds, which form it into whatever shape may be required; the tile being at the same time cut by the action of the machine to any desired length. Thus, every tile being pressed in precisely the same manner, passed through the same moulds, and cut off at exactly the same length, they all acquire an equal uniformity of size, strength, and stability, not to be attained to a similar extent by any other known mode of manufacture.

The tiles, being now made into form, are carried away by an endless web of canvass, over rollers which are turned by the same machinery, and thus travel of their own accord between sheds erected for their reception; in which they

* In that opinion the writer is joined by that experienced manufacturer, Mr. Boyle, of Ayr, in his *Essay upon Draining-tiles*, published in the "Prize Essays of the Highland Society" (No. xxxvii. p. 18), in which he thus expresses himself: "If the machine lately invented by the Marquess of Tweeddale comes into general use, (which, from what I know of it, it will, I feel confident), it will supersede moulding by manual labour, as it produces a superior article at a much less expense."

are placed in rows on either side by labourers stationed for that purpose, and are there kept until dried sufficiently for the final operation of burning.

By this means, four or five men can, with ease, make in a day from 8000 to 10,000 tiles; and when formed of good clay, and properly burned, they become so densely compact, that, if properly planted in the soil, it may be safely affirmed they would last almost for ever. Nor is durability, after the tiles are laid down, the only advantages in their construction; for every one who has used those made by hand will have experienced the great loss arising from breakage, in consequence of their want of firmness, both in their carriage from the tile-yard and by the labourers employed in putting them into the ground.

The size and form of the tiles and the soles (with which they are generally accompanied) are nearly the same as those in common use, with the exception of their length, which is 15 inches, instead of 12 to 13, as made in the ordinary mode; and the following table will explain the difference of number required by each sort for draining an acre of land at various distances:—

12 in. Tiles.		12½ in. Tiles.	13 in. Tiles.	15 in. Tiles.
3630..	At 4 yards apart..	3484.....	3351....	2904
2904..	5 do.	..2788.....	2681....	2323
2420..	6 do.	..2323.....	2234....	1936
2074..	7 do.	..1991.....	1914....	1659
1815..	8 do.	..1742.....	1675....	1452
1613..	9 do.	..1549.....	1489....	1291
1452..	10 do.	..1394.....	1340....	1162
1320..	11 do.	..1267.....	1218....	1056
1210..	12 do.	..1161.....	1117....	968

Thus making a difference of 20 to 25 *per cent.* in favour of the Tweeddale tiles.

Their prices vary, of course, with the cost of fuel and

labour, but are considerably lower than those of the tiles usually manufactured in the neighbouring districts; the company being enabled by their machinery to work not only cheaper, but better, and being satisfied with a less profit upon their large capital than would justly satisfy an individual. Indeed, the extensive demand among the great landholders at the present establishments of the company, (of which there are now, we believe, upwards of twenty in active employment in various parts of the kingdom,) and the patronage of the Commissioners of Woods and Forests, afford sufficient proofs of their superior value.

Land-draining, being, in fact, not only a tedious and laborious, but also in most cases an expensive operation, should never be undertaken but with a determination to do it effectually, by employing the best modes of workmanship and material; so as to ensure, as far as possible, the permanent improvement of the soil. *Stone-drainage* has that effect; but accompanied with these objections:—that the drains require to be sunk deeper than those of tiles; and that, in case of dead-levels, the fall must be made greater than when performed with tiles; also that vermin are apt to burrow in them; and, if the drains be set near to trees, the roots are attracted by the moisture, and the fibres, inserting themselves between the stones, sometimes fill up the conduit. There is also this great disadvantage attendant upon it:—that, as the operation is usually deferred until winter, when the ground is in a wet state, the land becomes so poached by the cartage of the heavy loads of stones which must be carried upon it, as frequently to injure meadow, and to occasion in arable land a serious increase of difficulty in the working.

The main objection, however, is the expense of carriage, which is frequently so burdensome as to occasion a preference to the employment of tiles. It has, indeed, been

stated by a very experienced drainer, that, "taking the cost of carriage at 5s. per day for each man and horse, and supposing the materials to be equidistantly situated from the respective drains, so that one cart conveys five loads of tiles and the other five loads of stones in the day, one cart, proportionally filled with 14-inch tiles and soles, will lay upwards of 100 yards of drain; while one cart, or cubic yard, of stones will only lay 18 yards of a similar sized drain, viz. 6 inches by 12: *being a saving of labour of six to one in favour of tiles.*"*

It may, indeed, be difficult to decide upon the comparative merits of tile and stone drainage, and the expediency of either must in most cases be governed by circumstances dependent upon the facility of procuring either the one or the other. A preference to the former is however not only given by the gentleman who has been just quoted, but also by several other eminent professional writers on the subject, who thus express themselves:—"I conceive, were burnt tiles laid on thick soles, and covered with turf, they would be preferable to stones, unless a sufficient quantity be used, and found within a mile of the operations."† "A tile and sole, with a few inches of stones, is the *ne plus ultra* of draining. I would recommend tiles to landlords who give any assistance to their tenants in draining, because they scarcely can make a bad drain with them, and seldom make a good one with stones, the carting of stones obliging them to neglect their other work."‡

In enumerating the comparative advantages and disadvantages of using tiles or stones in the execution of drains,

* Carmichael, of Raploch Farm, on Tile-Draining.—Prize Essays of the Highland Society, N.S., No. xxxviii. p. 97.

† Stephens on Furrow-Draining.—Quart. Journal of Agric., N.S., vol. iii. p. 293.

‡ Stirling, of Glenberrie, on Tile-Draining.—Prize Essays of the Highland Society, N.S., No. xxxviii. p. 108.

another also states, that, "if tile-drains are carefully executed, they will be found in every respect equal, if not superior, to the best stone-drains." *

In the account which has been already mentioned, of the Netherby estate, it is there also stated, that, "from estimates, which are strictly correct in practice, it would appear that, even supposing tiles are to be carried to the field to be drained a distance of three miles, or even more, and that a stone-quarry existed in the field itself, the drainage by means of tiles is by far the cheapest."

Tiles are, indeed, very generally thought to be, "when properly made and well burned, not only the handiest but the best material for setting in the bottoms of drains; for they ensure such a clear water-course, that a drain of two feet deep, set open at the bottom, is more effective than one four feet deep filled with rubble, and is not half so expensive." † They should, however, be invariably laid upon soles of about half an inch wider than the tiles, to guard them from slipping off; that mode being found far superior to that of laying them upon a naked bottom, both as securing them from sinking into the soil, and preventing the intrusion of moles, which will otherwise burrow under the tiles in search of earth-worms, upon which they feed, and sometimes occasion incalculable mischief. To prevent their sinking, tiles are often formed with flanges, or broad shoulders to rest upon; but the most obvious remedy to obviate the inconvenience is to lay them firmly upon soles, in the manner of a pavement; and, in sandy soils particularly, it is a necessary precaution.

In laying tiles and soles, the most usual mode is to place them along the edge of the drain, the tile-layer then fixing them alternately in close and regular order; uniting them

* Wilson on Tile-Draining.—Prize Essays of the Highland Soc., N.S., No. xxxviii. p. 121.

† On Underground-Draining.—Quart. Journal Agric., N.S., vol. v. p. 234.

at the same time so accurately as to guard against any obstruction to the stream of water ; he having his face to the work, and moving backwards until it is finished. The farmer should, however, carefully inspect every foot of the drain before he allows it to be covered.

The manner of *connecting the main and minor drains together*, though but little attended to, ought to be correctly done. A very common mode is to break off the corner from a main tile, for the purpose of inserting into it the end of one of the lesser sort, and allowing the water to enter ; in doing which the tile frequently breaks to pieces, thus occasioning both waste and trouble : or else a small space is left between two tiles in the main where the minor drain enters, and the aperture is covered with broken pieces. A better mode is, to leave an opening in the side of as many as may be required, for the insertion of the smaller ones, of the exact size of the mouth of the latter ; but, in either case, care should be taken to slope the bottom of the cross-drain gently down to the main receiver, so that their junction may be accurately effected.

In regard to the *covering of drains*, even experienced practical men are not agreed. The greater part, indeed, recommend some such porous material as peat, brushwood, tough haulm, or gorse, to be laid over them, to the depth of ten or twelve inches, before the return of the top-soil ; as that, if it be a tough clay, will, they say, prevent the filtration of the water, and partly impede the operation of the drain. While some assert, that, “ however strong the clay may be, it will not prevent the percolation,” for, according to an old adage, “ if one drop of water finds its way down, two will be sure to follow ;” and a few, as we have seen in the account of wedge-draining, prefer the ramming down of the top-soil, even of the strongest nature, immediately over the drains. It must be admitted, on the part of the latter, that

the effect of drainage will, in no great length of time, render the entire of the land so permeable, that the action of the drain will not then be seriously obstructed. The system advocated by the former is, nevertheless, the most prudent; and we learn, from some very experienced drainers, that, when the clay has been laid upon the tiles, it not only retains the water, but has been found to produce more rushes immediately over the drains than on any other part of the field. Perhaps small round stones, or clean gravel, if they can be easily had, are the best covering for the drain, if the soil be clay; or, if permeable, it may be safely thrown back; but, whatever material may be used, a green turf, cut thick, turned the grass side downwards, and put next the tile, between it and the covering, will be found a good precaution to secure it from damage.

It has been remarked by a late writer on agriculture, that, "were draining universally effected, the whole of the now comparatively unproductive soil of the country would to a vast extent be rendered capable of receiving the benefit of numerous modes of fertilizing it. Its returns are immediate as well as compensative; and to hesitate to drain the land is to hesitate to confer a benefit upon oneself." This is no doubt true when applied to the owners of the soil, but cannot be fairly urged to tenants; for no farmer under a rack-rent can be expected to expend his capital in making permanent improvements on another man's estate; and, even if his land be held upon more favourable terms, the proprietor should bear a fair proportion of the charge. Landlord and tenant have, in fact, no separate interest: they are united in one common bond, and, if they do not act together for their joint interest, they will both equally suffer. The landlord, however, has the greatest portion at stake in the profit arising from the melioration of the property, for it remains to him and his descendants for ever,

while the tenant can only reap benefit from it during the duration of his lease.

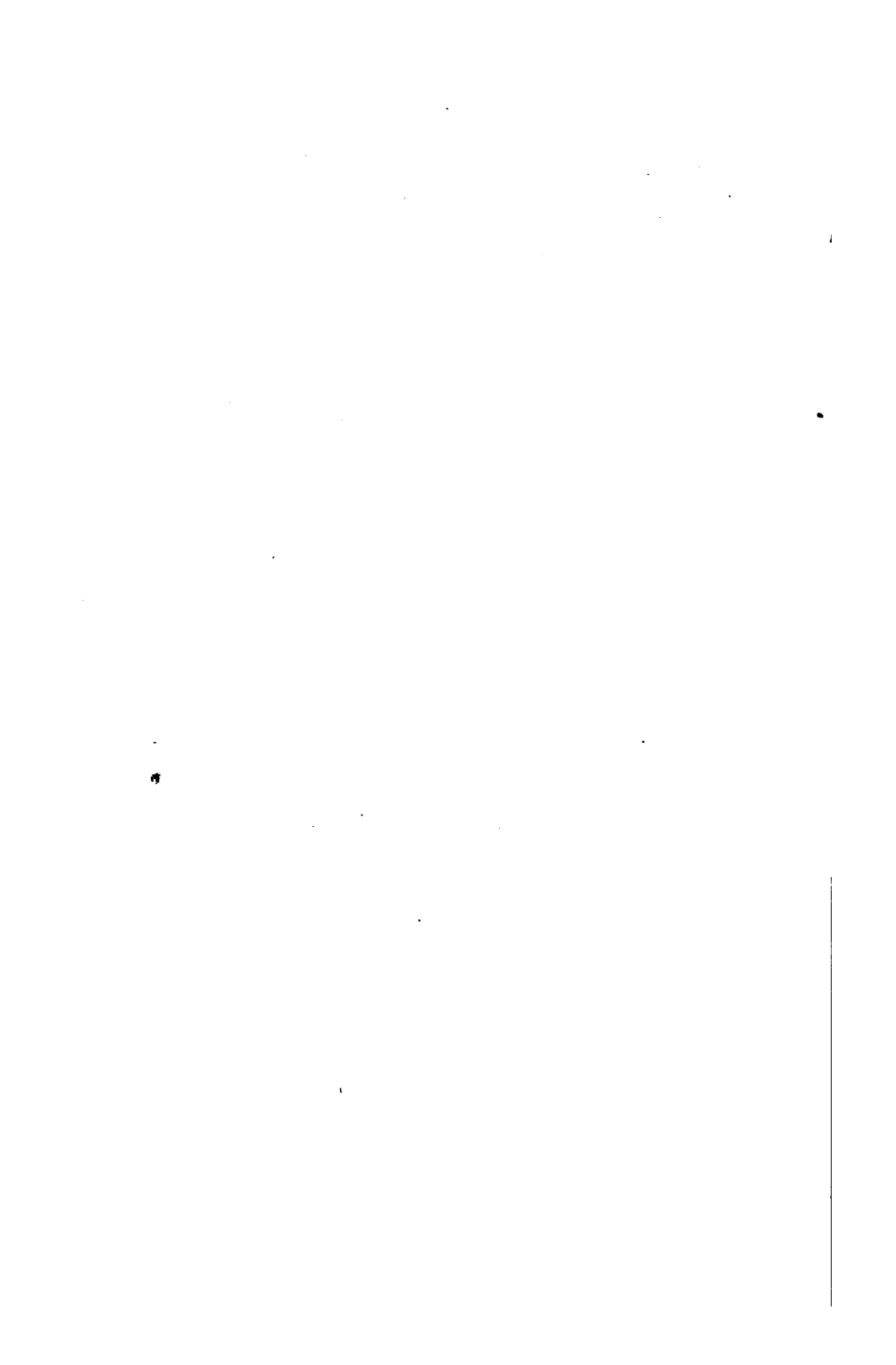
The term of that lease should, however, govern the amount of mutual remuneration; for the landlord has an undoubted right to share in the profits of the tenant who is farming his property, in a due proportion of increased rent. It is, in fact, a bargain between man and man, without reference to rank, and should be governed by the just, as well as liberal, trading principle of "Live, and let live."

The landlord, therefore, in some cases either pays the whole cost, for which he charges an additional rent; or, more usually, supplies the tenant with tiles at the cost price, merely charging interest on the amount: the farmer carrying them from the manufactory and bearing the charge of labour.* An arrangement, it may be observed, which is conducive to the interest of both; for, if the landlord is to have the future benefit arising from the improvement of the soil, the tenant enjoys the present profit of working it. But, whether looking to present or future advantage, if the landlord has not in his employment a careful and intelligent steward resident on the estate, he will do wisely to have the operation performed under the inspection of a trusty well-informed bailiff, in a manner to render it substantially durable. In doing so, he need not be alarmed, for it will assuredly repay the expense. He will not only be reimbursed by the certainty of obtaining a higher rent for his land, when put into condition by drainage, but it also can never want a tenant; for the farmer not only works cheerfully on a soil of that improved

* With this view, a large manufactory for draining-tiles, on the Tweeddale Patent, has been established on the estate of Earl Grey; and his Lordship, with that prudence and liberality by which he has ever been distinguished as a landlord, has instituted an expensive process of draining, at his own cost, for which outlay the tenants pay only common interest.—*Journ. of the Roy. Ag. Soc. of England*, vol. ii. p. 159.

nature, but receives a more certain as well as a larger return for his industry and capital.

One would suppose that, viewing all these advantages, not an acre of wet land would be left undrained of the ten millions which are supposed to stand in need of that improvement in this country. But, although alive to the increased value which it would impart to the soil, yet the undertaking is sometimes impeded by disagreements between landlord and tenant, both regarding the cost of drainage and the terms of lease; as well as by difficulties occasioned by the settlement of many entailed estates, which render the life-tenants disinclined to incur the charge. This, however, will be partly remedied by a late enactment of the legislature, enabling the owners to defray the expense of draining by way of mortgage. In addition to which, a clause will probably be moved for in the next session of parliament, by the gentleman who introduced the bill, to extend its provisions to ecclesiastic, collegiate, and corporate property;—perhaps also avoiding the expensive mode of applications to the Court of Chancery; and it will no doubt be extensively aided by an institution, now in the course of formation, for the employment of capital in the draining of land upon the principles laid down in the Act: the recitals of which are hereunto annexed.



4th August, 1840.

An Act to enable the Owners of Settled Estates to defray the Expense of Draining the same by way of Mortgage.—Cap. lv.

“ WHEREAS much of the land in England and Ireland would be rendered permanently more productive by improved draining, and nevertheless, by reason of the great expense thereof, proprietors having a limited interest in such land are often unable to execute such draining: And whereas it is expedient, as well for the more abundant production of food, as for the increased employment of farming labourers, and the extended investment of capital in the permanent improvement of the soil, that such proprietors should be relieved from this disability, due regard being had to the interests of those entitled in remainder: Be it therefore enacted by the Queen’s most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present parliament assembled, and by the authority of the same, that from and after the passing of this Act it shall and may be lawful for any tenant for life, or for a term determinable on his or her life, under any will, settlement, or other like disposition, entitled in possession at law or in equity to any lands in England or Ireland, (or the guardian or guardians of any infant, on the behalf of such infant so entitled as aforesaid,) to apply by petition to her Majesty’s Court of Chancery or Exchequer in England or Ireland for leave to make any permanent improvements in the lands to which he or she shall be so entitled, or any part thereof, by draining the same with tiles, stones, or other durable materials in a permanent manner; and in every such petition shall be specified the improvements proposed to be made, and the estimated cost thereof, and of all matters incidental thereto; and every such petition shall be referred to a master of the said Court of Chancery, or to a master, or in Ireland to the chief or second remembrancer, of the Court of Exchequer, to inquire into and ascertain the propriety of such improvements being effected; and such master or chief or second remembrancer shall and he is hereby required to call for such plans and estimates and

Tenants for life may apply to Court of Chancery for leave to make improvements.

specifications in relation to the said proposed improvements as he shall think fit; and the master or remembrancer shall make his report respecting such proposal; and the court to which any such application shall be made shall make such order upon such petition and report as such court shall think fit.

copy of petition to be served on parties interested.

“ II. Provided always, and be it enacted, that a copy of every such petition shall be served twenty-one days at the least before the hearing thereof upon the person or persons beneficially entitled at law or in equity to the first vested estate of freehold of inheritance in remainder after the estate of the tenant for life, but if any of such persons shall be of unsound mind, or under the age of twenty-one years, or under any other legal disability, or beyond the limits of the United Kingdom of Great Britain and Ireland, then a copy of such petition shall be served on his, her, or their behalf, upon such person or persons respectively as the said Court of Chancery or Court of Exchequer to which the said petition shall be preferred shall appoint for that purpose; and every person upon whom a copy of any such petition shall be so served shall be at liberty to attend before the master or remembrancer to whom such petition shall be referred, and to consent or object to the proposal contained in such petition; and any person appearing before the master or remembrancer on any such petition may also appear before the master or remembrancer, previously to his signing any such certificate as after mentioned, for the purpose of producing any objection to the mode in which any such improvements as after mentioned may have been executed; and all the costs attending any such application, and of the party so served, shall be paid by the party making such application as aforesaid.

tenants for life may make improvements.

“ III. And be it enacted, that if it shall appear to the satisfaction of such master or remembrancer, on the report of one or more surveyors to be appointed or approved of by the said master or remembrancer, that it will be for the benefit of such lands that they should be so drained, and such report shall be confirmed by the said court, then it shall be lawful for the tenant for life, or such guardian or guardians as aforesaid, who shall have presented such petition, to make and execute such improvements accordingly.

“ IV. And be it enacted, that in every case where the After im-
said Court of Chancery or Exchequer shall have made an order sanctioning the execution of any such improvements made, Court
of any lands, and such improvements or any part thereof to ascertain
shall have been made accordingly, it shall be lawful for has been
the master or remembrancer whose report shall be so con- properly ex-
firmed by the said court, by a certificate under his hand pended, and
to be filed in the said court, on having satisfaction that the to order it to
money had been properly expended, to authorize any such be charged.
person so entitled as aforesaid, or the executors or admin-
istrators of such person, or such guardian or guardians of
such infant as aforesaid, by deed in writing, to charge all
or any part of the lands so drained as aforesaid, or any
other lands subject to the like uses or trusts as the lands
so drained, with the payment to any person or persons
willing to advance the same of the amount of the money
which may have been so expended, and so from time to
time as any money shall be so expended, together with
interest thereon after any rate not exceeding *five pounds
per centum per annum* from the time of making the charge,
but so nevertheless that in any such charge it shall be
provided that the principal sum charged shall be paid off
by equal yearly instalments, such instalments not to be
less than twelve nor more than eighteen, the number of
such instalments to be determined and recommended by
the said master or remembrancer in his report, and such
number of the said instalments to be diminished or in-
creased at the discretion of the said master, according to
the greater or less improvement shown to have been made
by such draining ; and for the purpose of securing such
moneys to be so charged it shall be lawful for the person
making such charge to demise the hereditaments to be
charged for any term or number of years, by reason
whereof the rents and profits of the said hereditaments
shall be applicable to the payment of the said moneys so to
be charged as aforesaid, but so as such term be made to
cease on the payment of the moneys charged : Provided
nevertheless, that such person making such charge, and
every succeeding tenant for life, or tenant for term of
years determinable on his or her life, shall be bound to
keep down the interest and instalments to be charged, or
any rent-charge to be charged as after mentioned ; and
the lands charged shall not (except as against any tenant
for life or other person liable to pay such instalments and

interest or keep down such rent-charge) be liable to pay more than six months of any interest and one half of any instalment, or pay more than half a year's rent-charge, which is hereby directed to be kept down as aforesaid: Provided nevertheless, that if any person shall be willing to advance to any person hereby authorized to make such charge as aforesaid the amount he or she may be so authorized to charge in consideration of a rent-charge for a term of not less than twelve nor more than eighteen years, then such person so authorized to charge, instead of charging the said hereditaments with such instalments and interest as aforesaid, may charge the same with a rent-charge for any such period as aforesaid, so as that the said master or remembrancer shall in his said report approve of the substitution of a rent-charge, and of the amount to be charged, and shall ascertain and determine the number of years for which the same shall be granted (such number of years to be ascertained in the same manner as is before directed with respect to the ascertaining the amount of such instalments as aforesaid): Provided also, that no person shall be entitled to make any such charge as aforesaid unless it shall be stated in the report of such master or remembrancer that it hath been made to appear to him by the report of such surveyor that the annual value of the lands so drained is increased by such draining to an amount equal to *seven pounds per centum* at least on the sum to be charged.

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